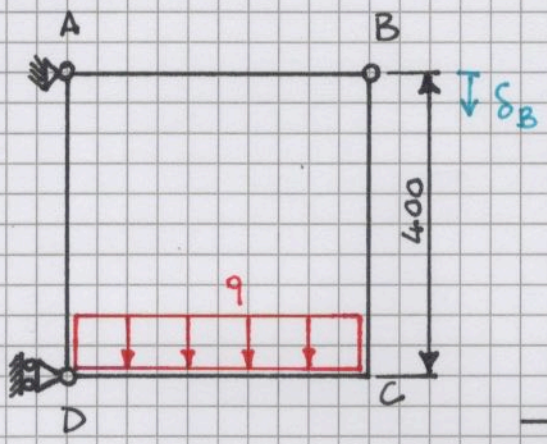


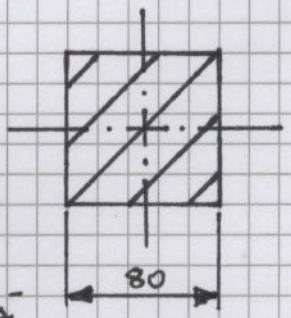
CARICO : $q = 2\ N/mm$

MATERIALE : ACCIAIO $E = 210\ GPa$

$\nu = 0.3$

$G = 80.769\ GPa$

SEZIONE : QUADRATA



$A = 80^2 = 6400\ mm^2$

$I = \frac{80^4}{12} = 3\,413\,333.3333\ mm^4$

$\chi = \frac{6}{5} = 1.2$

STATICITÀ E LABILITÀ

NODO	GDV
A	4
B	2
D	3
TOT. GDV =	9

GDL : N° ASTE · 3 = 3 · 3 = 9

STRUTTURA ISOSTATICA

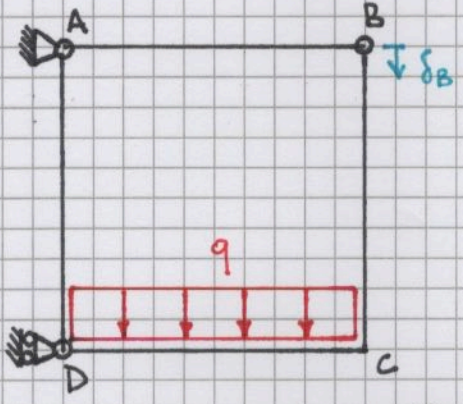
La struttura è composta da 3 travi:
l'asta DCB è un unico corpo rigido che può essere schematizzato come un collegamento rigido tra D e B.

La struttura equivalente è quindi un arco a 3 cerniere chiuso e NON LABILE per definizione.
Quest'ultimo è vincolato da un carrello in D e una cerniera in A, posti in modo che la linea dei CR del carrello non intersechi mai la cerniera A. Pertanto la struttura è NON LABILE.

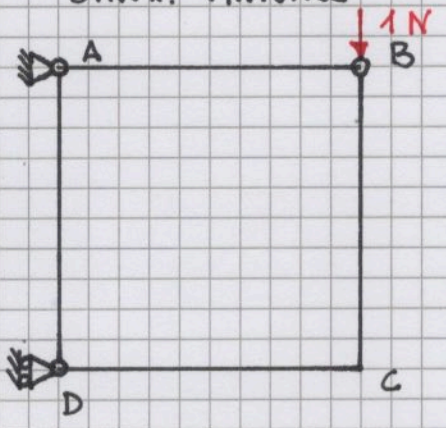
CALCOLO DELLO SPOSTAMENTO δ_B DEL PUNTO B

Per il calcolo dello spostamento del punto B si utilizzerà il principio dei Lavori Virtuali. Servirà analizzare due strutture, una REALE e una VIRTUALE.

STRUTT. REALE



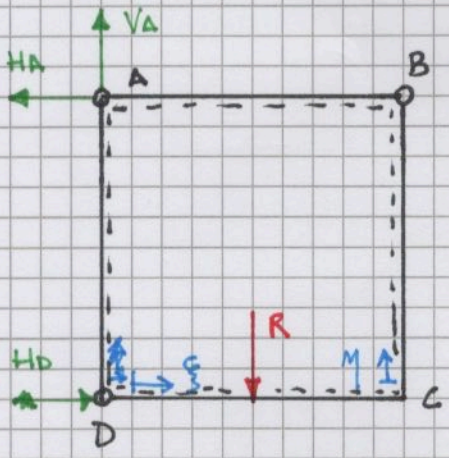
STRUTT. VIRTUALE

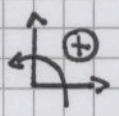


Analizziamole una alla volta.

ANALISI STRUTTURA REALE

- ANALISI REAZIONI VINCOLARI A TERRA





$R = 2 \cdot 400 = 800\ N$

$\rightarrow^+$ $H_D - H_A = 0$ $\quad H_D = H_A$

$\uparrow^+$ $V_A - R = 0$ $\quad \cdot V_A = 800\ N$

$\circlearrowleft_A^+$ $-R \cdot 200 + H_D \cdot 400 = 0$

$\cdot H_D = \frac{R \cdot 200}{400} = 400\ N$

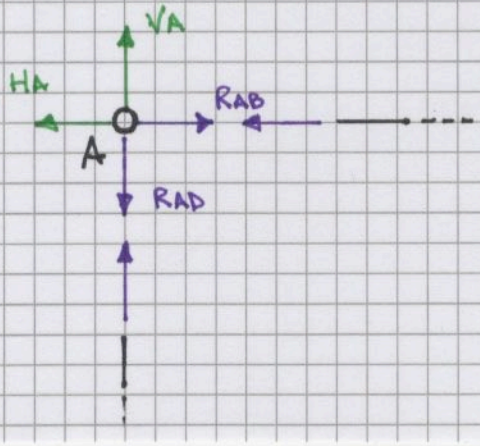
$\cdot H_A = 400\ N$

- ANALISI REAZIONI VINCOLARI INTERNE

Le aste $\overline{AD}$ e $\overline{AB}$ sono BIELLE SCARICHE.

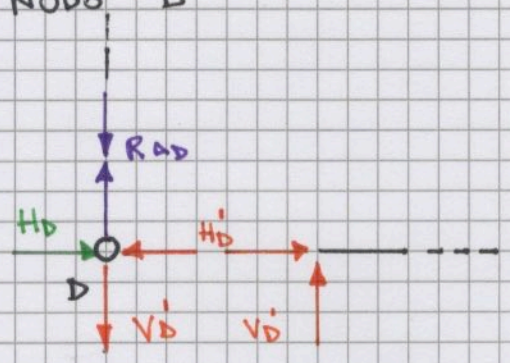
Procediamo all'equilibrio dei Nodi A e D.

NODO A.



$$\begin{cases} R_{AB} = H_A = 400N \\ R_{AD} = V_A = 800N \end{cases}$$

NODO D



$$\begin{cases} V_D' = \underbrace{R_{AD}}_{800N} \\ H_D' = H_D = 400\,N \end{cases}$$

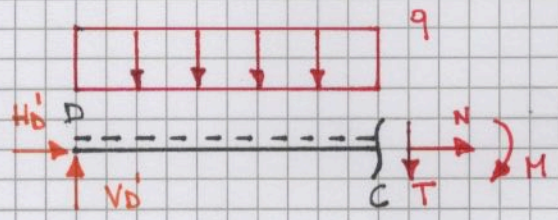
- AZIONI INTERNE

Nelle aste $\overline{AB}$ e $\overline{AD}$ è presente solo azione normale quindi:

$$N^{(R)}_{AD} = R_{AD} = +800\,N \qquad N^{(R)}_{AB} = R_{AB} = +400\,N$$

Per l'asta DCB è necessaria la solita procedura.

TRATTO $\overline{DC}$ $\quad 0 < \xi < 400$



- $N^{(R)}_{DC} = -H_D' = -400N$
- $T^{(R)}_{DC} = V_D' - q\,\xi$

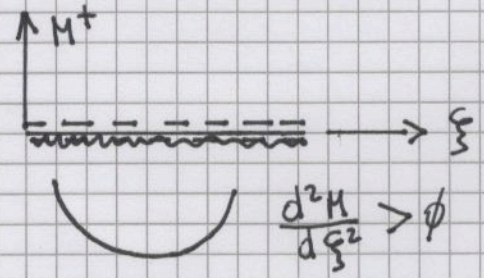
$T(\emptyset) = V_D' = 800N$

$T(400) = \emptyset$

$T = \emptyset$ in $\xi = 400$ mm

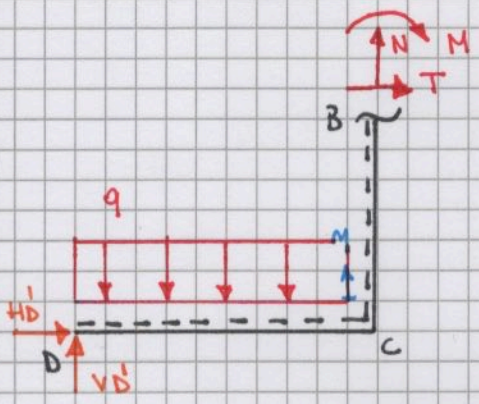
- $M^{(R)}_{DC} = -V_D'\,\xi + q\,\frac{\xi^2}{2}$

$M(\emptyset) = \emptyset \qquad M(400) = -160'000\ N\cdot mm \qquad \frac{d^2M}{d\xi^2} > \emptyset \rightarrow$ concavità verso la direz. POSITIVA DEI MOMENTI



ANALISI STRUTTURA REALE

- TRATTO $\overline{CB}$ $\quad 0 < \eta < 400$



~~$N^{(R)}_{CB} = -V'_D = -800\,N$~~

$$N^{(R)}_{CB} = -V'_D + q \cdot 400 = \emptyset$$

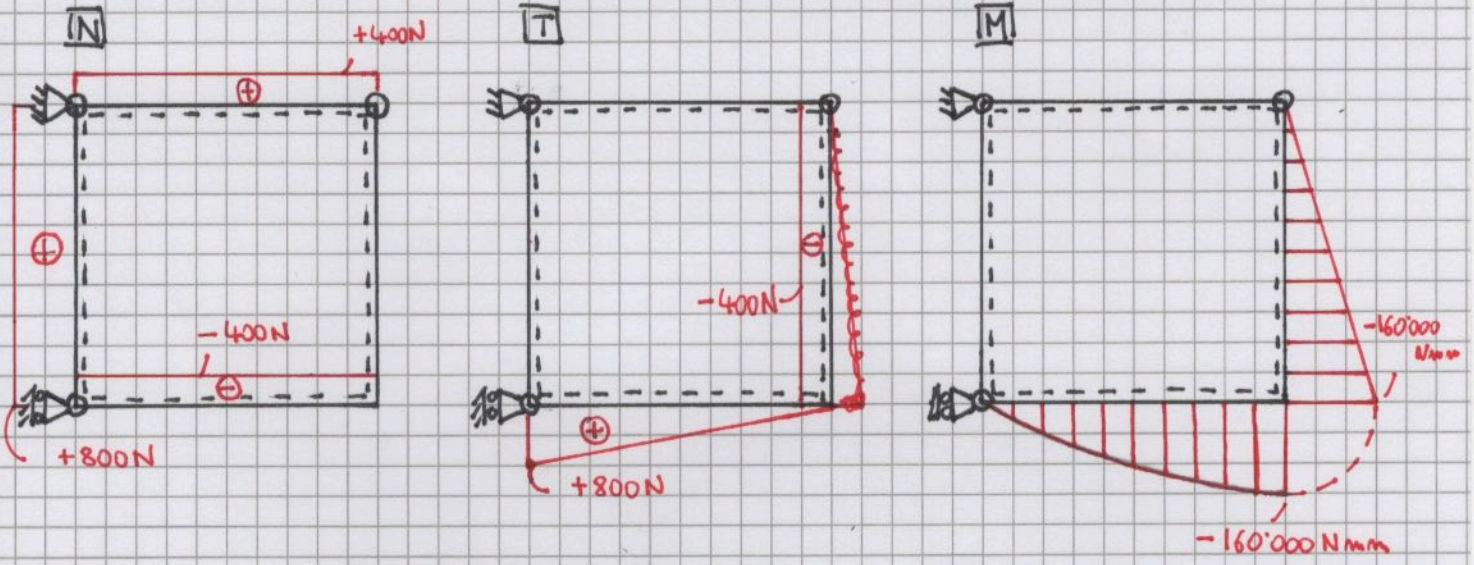
$$T^{(R)}_{CB} = -H'_D = -400\,N$$

$$M^{(R)}_{CB} = -V'_D(400) + H'_D \cdot \eta + q \cdot (400)(200) =$$

$$= 400\eta - 160'000$$

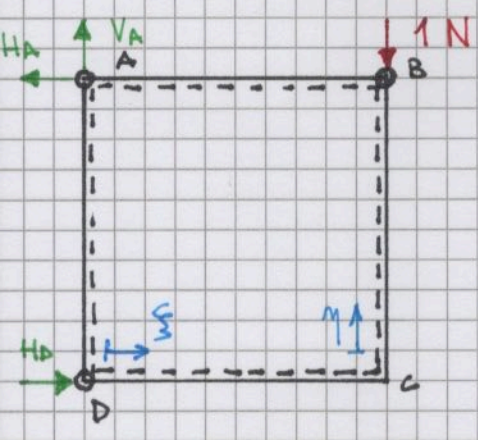
$$M(\emptyset) = -160000\ N \cdot mm \qquad M(400) = \emptyset$$

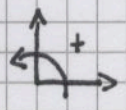
DIAGRAMMI AZIONI INTERNE STRUTTURA REALE



ANALISI STRUTTURA VIRTUALE

- CALCOLO REAZIONI A TERRA





$\uparrow^{+}$ $\quad V_A - 1 = \emptyset \quad \bullet\ V_A = 1\,N$

$\rightarrow^{+}$ $\quad H_D - H_A = \emptyset \quad \bullet\ H_A = H_D$

$\curvearrowleft_{A}^{+}$ $\quad H_D \cdot 400 - 1 \cdot 400 = \emptyset$

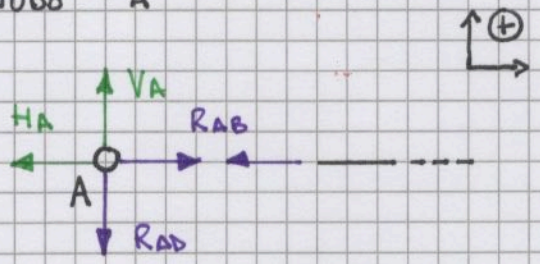
$\bullet\ H_D = 1\,N$

$\bullet\ H_A = 1\,N$

ANALISI STRUTTURA VIRTUALE

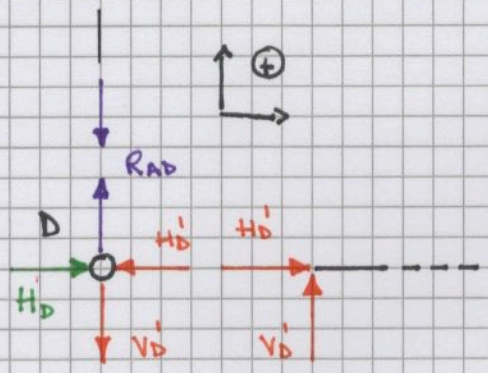
- CALCOLO REAZIONI INTERNE

NODO A



$$\begin{cases} R_{AD} = V_A = 1N \\ R_{AB} = H_A = 1N \end{cases}$$

NODO D



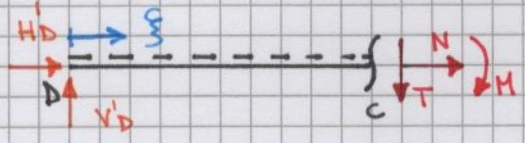
$$\begin{cases} H'_D = H_D = 1N \\ V'_D = R_{AD} = 1N \end{cases}$$

- AZIONI INTERNE

Come nel caso precedente le aste $\overline{AB}$ e $\overline{AD}$ è presente solo azione normale, poiché sono BIELLE SCARICHE.

$N^{(v)}_{AD} = +R_{AD} = +1N$ $\qquad$ $N^{(v)}_{AB} = +R_{AB} = +1N$

TRATTO $\overline{DC}$ $\quad 0 < \xi < 400$



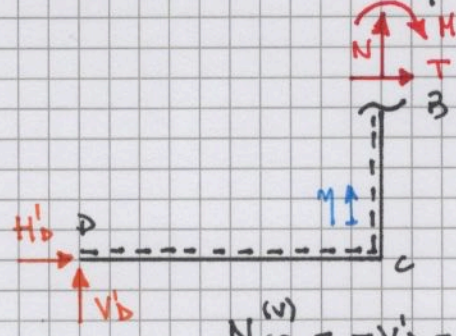
$N^{(v)}_{DC} = -H'_D = -1N$

$T^{(v)}_{DC} = V'_D = 1N$

$M^{(v)}_{DC} = -V'_D \cdot \xi = -\xi$

$M(\emptyset) = \emptyset \qquad M(400) = -400$ N·mm

TRATTO $\overline{CB}$ $\quad 0 < \eta < 400$



$N^{(v)}_{CB} = -V'_D = -1N$

$T^{(v)}_{CB} = -H'_D = -1N$

$M^{(v)}_{CB} = -V'_D(400) + H'_D \eta =$

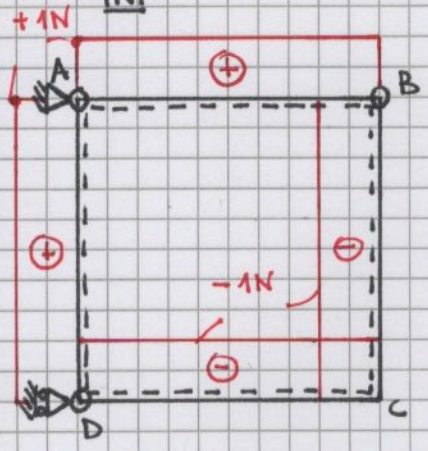
$= -400 + \eta$

$M(\emptyset) = -400$ N·mm

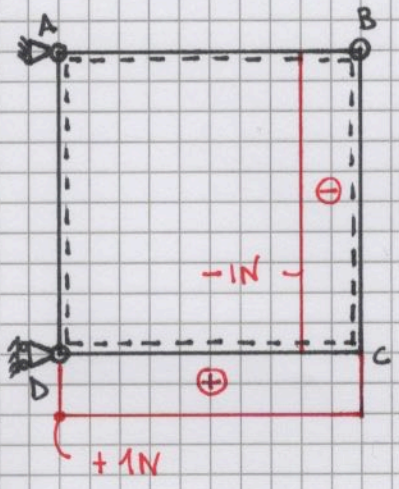
$M(400) = \emptyset$

DIAGRAMMI AZIONI INTERNE STRUTTURA VIRTUALE

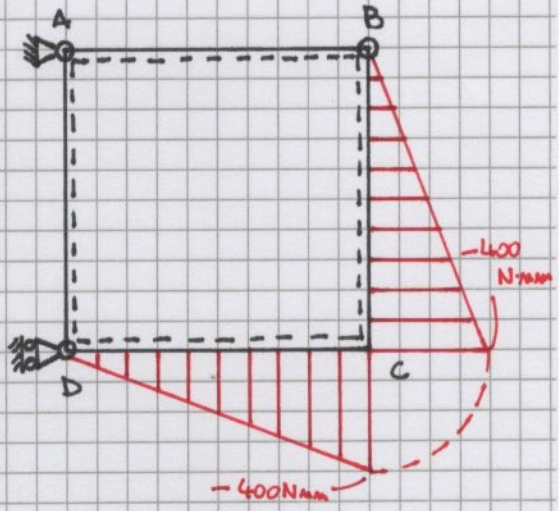
N



T



M



CALCOLO SPOSTAMENTO

$$\mathcal{L}_{INT} = \int_0^{400} \frac{N_{AB}^{(N)} N_{AB}^{(R)}}{EA} dx + \int_0^{400} \left[\frac{N_{BC}^{(V)} N_{BC}^{(R)}}{EA} + \chi \frac{T_{BC}^{(V)} T_{BC}^{(R)}}{GA} + \frac{M_{BC}^{(V)} M_{BC}^{(R)}}{EI} \right] dy$$

$$+ \int_0^{400} \left[\frac{N_{CD}^{(V)} N_{CD}^{(R)}}{EA} + \chi \frac{T_{CD}^{(V)} T_{CD}^{(R)}}{GA} + \frac{M_{CD}^{(V)} M_{CD}^{(R)}}{EI} \right] d\xi + \int_0^{400} \frac{N_{AD}^{(V)} N_{AD}^{(R)}}{EA} dy =$$

$$= 1.1905\,E{-}04 + 0.0123 + 0.0154 + 2.3810\,E{-}04 =$$

$$= 0.0280$$

$$\mathcal{L}_{EST} = 1 \cdot \delta_B \qquad \mathcal{L}_{EST} = \mathcal{L}_{INT}$$

$\delta_B = 0.0280$ mm → positivo: significa che lo spostamento avviene nello stesso verso in cui è posizionata la forza esplorativa unitaria.